



Back-to-Basics

Best practices for using monitoring system outputs

by Steve Sabin

Marketing Manager,
Control System Relationships
Bently Nevada Corporation

Bently Nevada's monitoring systems have numerous outputs for connection to other control and automation products. Some of these are:

- Relay contacts
- Visual meters and status indicators on the monitor front panel
- Analog proportional signals (i.e. recorder outputs)
- Digital communication protocols (e.g. Modicon Modbus®)

In this article, I will review the intended application of these signals and offer some general guidelines for best practices.

Relay contacts for machinery protection

Bently Nevada defines machinery protection as:

"Products that provide shutdown of a machine or return it to a safe or non-destructive mode of operation without human intervention."

Machinery protection is the most basic and fundamental purpose of a monitoring system.

Beginning with our very first 5000 Series Monitors in the mid 1960's, Bently Nevada monitors have always included Alert and Danger setpoints and corresponding relay contacts for machinery protection. We continue to do so in today's monitoring systems. Hardwiring these relay contacts to the machine or turbine control system, to the machine emergency shutdown system, or directly to the machine shutdown mechanism continues to be our recommended practice for the simplest and most reliable method of machinery protection.

Later in this article, I will provide additional information on why we consider this to be "best practice." In the meantime, let's look at additional outputs from the monitoring system.

Front panel displays

Another important function of the monitor is to provide very basic information, such as overall amplitude of vibration, gap voltage, alarm and instrument status, to operators and machinery specialists. The key concept here is *basic information*. The information provided by the monitor should not be confused with the additional machinery diagnostics and data acquisition information provided by other Bently Nevada products, such as the Data Manager® 2000 for Windows NT.

Historically, operators and other plant personnel were provided with this basic information by the indicators on the monitor front panel. Therefore, many of our monitoring systems have previously been installed either at the machine site,



for the benefit of the machinery engineer during machine starts and stops, or were often located in the control room, within easy sight of operators. As we will see, this has been changing.

Recorder outputs

In addition to relay contacts and local monitor front panel displays, a third output from our monitoring systems is an analog proportional signal. Early in the evolution of our monitoring systems, it became apparent that the ability to trend information provided more value than the simple "current values and current status" information available at the monitor front panel. Our customers began requesting that our monitoring systems be connected to strip chart recorders, often located in the control room. In response, Bently Nevada began providing dedicated analog proportional signals for each channel, such as 1-5 Vdc, 0-10 Vdc, and, eventually, the industry-standard 4-20 mA signal that is most prevalent today. Since the original intent of these outputs was to drive strip chart recorders, Bently Nevada did, and still does, refer to these as *recorder outputs*.

With the advent of digital process control systems in the mid 1980's, such as DCSs and PLCs, the use of strip chart recorders diminished. Instead, the control system could trend process parameters and other information on computer hard disks. Also, the control system's human machine interface software and computer screens began to take the place of older panel boards full of meters and "stand alone" instruments. The process control system's human machine interface evolved to become the operator's "single window" not just to the process, but to all related subsystems, such as the vibration monitoring equipment.

This naturally led to a de-emphasis on the importance of monitor front panel meters and indicators. Monitoring systems increasingly began to show up in termination rooms, field auxiliary rooms and other locations where the operator could no longer see them. Instead, recorder output signals were connected to the process control system, which provided basic indication and trending functions.

Digital communications

As process control systems evolved, new methods of interfacing to them evolved as well. In particular, the costs associated with hardwiring individual recorder output signals to the control system, as a means of providing basic operator information and trending, were addressed. This was done by communicating the data digitally to the process control system over a single cable using protocols, such as Modicon Modbus®. The digital communications capability in our monitoring systems evolved primarily as a more efficient way to interface to the control system than was possible using individually hardwired recorder outputs. An analog recorder output was designed to provide only a single parameter for each channel in the monitoring system. With digital communications, the monitor could process the signal into additional parameters beyond overall vibration amplitude, such as gap voltage, 1X amplitude, and 1X phase lag. It could also supply these parameters over a single cable for multiple channels in multiple racks. This generally made it more economical to provide basic information to the process control system and also provided additional data that was impractical when only recorder outputs were used.

To summarize, the digital communications capabilities in our monitoring systems evolved to replace the older recorder outputs, as a way of interfacing to the control system. Recorder outputs were designed to provide basic information and trending capabilities needed by operators.

We have provided this background information on our outputs to give you some appreciation of why these features have been included in our monitoring systems. Generally, when customers use these outputs as described above, they are consistent with Bently Nevada's intended application of the outputs. Next, we will discuss the practice of using recorder outputs or digital communications links from the monitor for machinery protection purposes, and offer some comments based on our

"Products that provide shutdown of a machine or return it to a safe or non-destructive mode of operation without human intervention."

experiences and accumulated knowledge.

Field device practices

As control systems evolved, so did field devices. A common direction among many companies today is to replace simple field devices, that incorporate discrete outputs, such as level, flow, or pressure "switches," with more sophisticated devices capable of continuous proportional outputs. The rationale is that simple discrete devices generally have little embedded intelligence, and can often fail in a manner that is undetected—until they are needed. It is a bit like the warning lights on your automobile dashboard—it is impossible to distinguish between "no problem" and a burnt out indicator light unless your car has some more advanced diagnostic indicators.

By using a device with a continuous output, the operator can significantly increase his knowledge of the process and his confidence in the correct operation of the field device. Sudden changes in readings (or readings that fail to change at all) may indicate a fault with the field device. A controller can perform more sophisticated "OK checks" on a proportional signal than it can on a simple contact closure. Values relative to full scale, zero scale, and alarm settings can be seen readily, and rate-of-change can be seen as well. The ability to view and trend this information increases confidence in the correct operation of the instrumentation and encourages operators to "trust" the instruments.

The monitor . . . just another simple field device?

While the above arguments hold true for simple field devices, caution should be taken before applying this reasoning to all discrete signals, such as the relay contacts on a Bently Nevada monitoring system. The Bently Nevada monitoring

system is capable of sophisticated OK checks and self-monitoring. This differentiates it from simple switches. Although the outputs for machinery protection are relay contacts, the circuitry that drives these contacts employs significant proprietary embedded intelligence to ensure that false and missed trips are minimized and that legitimate high vibration is differentiated from instrumentation problems and transducer faults.

Another compelling reason for using Bently Nevada's relays is that it relieves the control system programmer from the burden of programming similar functions into the control system. These functions are already embedded in the monitor. Alarming, hysteresis, time delays, watchdog checks, scan times, alarm suppression under instrument fault conditions and other issues must all be addressed when customers attempt to duplicate the monitor functions in their control system. The ability to provide meaningful OK checks, comparable to those embedded in our monitoring systems, is greatly diminished when the input to the control system is simply a 4-20 mA or other proportional signal.

When the monitoring system is used for machinery protection, another important consideration is the practice of segregating protective functions from basic process control functions. It is generally recognized that good practice is to use the process control system for just that . . . process control. Good practice dictates that separate and distinct systems should be employed for emergency shutdown applications, such as machinery shutdowns. These systems should not rely on the operation of the process control system. Hardwiring recorder outputs into the process control system and using them for alarming and shutdown violates this basic premise.

Finally, Bently Nevada advocates the use of relay contacts for machinery pro-

tection because it often results in lower installed costs without compromising the integrity or capability of the protection system. Inside the monitor, Bently Nevada is able to provide the voting logic among channels required for the particular machine protection strategy employed. Thus, a single relay (or even redundant relays) can be provided that reflects the desired voting logic. The alternative is to hardwire individual recorder outputs into the control system and perform all alarming and voting logic in the control system. This implies larger installation costs, as each recorder output must be connected to the control system rather than a single relay or possibly several redundant relays. As noted above, the configuration and programming costs of the control system must also be considered.

Operator information and trending

As we have suggested above, relay contacts are the preferred method for

implementing machinery protection functions. This leaves the monitor front panel, recorder outputs, or digital communication links as alternatives for operator information and trending. In most cases today, the preferred location for this basic information is at the control system operator interface. It can effectively emulate the monitor front panel displays or present the information in an even more intuitive format, such as a machine train block diagram. This is also consistent with the general trend of presenting all operator information in a "single window to the process" — the control system operator console.

As a general rule, digital communications links are generally more cost-effective, as the number of points in the monitoring system increases. Wiring costs and control system I/O hardware is generally less expensive for many points over a single cable than with individual I/O terminations and individually hardwired cables.

Conclusion

- We advocate the use of our relay contacts for machinery protection.

- Neither recorder outputs nor digital communications links are intended for machinery protection — they were designed for basic operator information and trending purposes.

- Our monitoring systems incorporate significant embedded intelligence to minimize false and missed trips. These functions are difficult or impossible to duplicate using analog proportional outputs and conventional process control system hardware.

We continually improve the value in our monitoring systems by making them "smarter" and less susceptible to transducer and instrumentation problems. In many cases, a single false trip or missed trip will pay for the system many times over. We recognize the trust you place in our products to protect and manage your machinery. We hope you will find these recommendations both useful and practical. ■